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GIS AS A DECISION SUPPORT FOR SUPPLY CHAIN MANAGEMENT

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ABSTRACT

A supply chain is a network of facilities and distribution options that performs the functions of procurement of materials, transformation of these materials into intermediate and finished products, and the distribution of finished products to customers. Supply Chain Management (SCM) is the process of planning and management of materials, information and financial flow in a network consisting of manufacturers, distributors, suppliers and customers with the objective of reducing the costs, increasing the business and improving the customer service.

GIS can be used as a tool to map manufacturing, clients, processing units, supplier locations, distribution centers, and routing of vehicles. GIS can be used as a decision support for effective supply chain management.

In the system, the data of the processing units, the customers, the distribution centers, the suppliers, and the topologies of the roads are stored and managed by the geographic information system (GIS). Badaun district of western U.P. region is considered as the study area. The supply chain management is facilitated for the parag co-operative milk production units.

The system will answer to the following queries of the user:

- What is the drive time from the central facility to any other location?
- How long will it take to reach delivery locations?
- Which customer will be in which service area?
- How can the goods be tracked through the supply chain?
- What will be the shortest route between two points in the supply chain network?
- What will be the alternative path between two points other than the normally followed shortest path?

Finally a comparison between the supply chain network of parag co-operative milk production units and other private sector milk production units is performed and some changes are proposed on the bases of this comparison.

KEYWORDS: Supply Chain Management, Routing, Shortest Path, GIS

1. INTRODUCTION

A Geographic Information System (GIS) is an organized collection of computer hardware, software, geographic data and personnel designed to efficiently capture, store, update, manipulate, analyze and display many forms of geographically referenced information (ESRI, 1995). From many years, GIS had been build based on a centralized paradigm where the complete set of data is stored on single server. Much recent attention has focused on developing GIS functionality in the Internet/ World Wide Web and private intranets and is termed as Web GIS.

Web GIS holds the potential to make distributed geographic information (DGI) available to a very large worldwide audience. WebGIS are available for the public to participate in finding solutions to a wide variety of real-world spatial problems and allow users to examine spatial information and meta-data[4]. The users can add own information in multimedia formats, discuss and share the datasets and form interested communities, as well as examine the spatial datasets and manipulate them to run "what if" scenario models to reach an informed decision. Web services allow implementation of a decentralized paradigm for creation of a complex distributed applications from multiple GIS services which provide limited functions to the local data. A decision-support system is an integrated set of computer tool that allows a decision maker to interact directly with computers to create information useful in making semi-structured and unstructured decisions. The software components for decision-support systems are a language system which enables the user to interact with the decision-support system, a problem-processing system which is made up of several components that perform various processing tasks and a knowledge system which provides data and artificial-intelligence capabilities to the decision-support system. The present paper proposes a new approach for building a GIS based decision support system for the supply chain management.

2. SUPPLY CHAIN MANAGEMENT

A supply chain is a network of facilities and distribution options that performs the functions of procurement of materials, transformation of these materials into intermediate and finished products, and the distribution of finished products to customers. In today's highly competitive market manufacturers face the challenge of decreasing manufacturing cycle time, delivery lead-time and inventory reduction. It is the core interest of decision makers to reduce the cost, expanding the business improving the customer service, improving the quality of finished goods and reducing the time taken in producing finished goods[6]. In the early 1990s, the phrase "supply chain management" came into use. Supply chain management can be defined as a process of integrating suppliers, manufacturers, warehouses, and retailers, so that the goods are produced and delivered at the right time in the right quantities while minimizing cost as well as satisfying customer requirements. Supply Chain Management (SCM) is the process of planning and management of materials, information and financial flow in a network consisting of manufacturers, distributors, suppliers and customers with the objective of reducing the costs, increasing the business and improving the customer service. Figure 1 shows the key concepts of supply chain management [6].

2.1 Role of GIS in Supply Chain Management

Geographic information system can be very useful in supply chain management. Geography matters a lot when the decision to be taken or the problems to be tackled are spatial in nature. GIS is emerging as a very effective tool in the industries that involve logistics or use the transportation services[7]. The main problem to be tackled in supply chain management is of the routing - to find the shortest path between two locations and to find the alternative path in case of any problem in the shortest route. GIS and spatial analysis can be very effective at solving routing problems because it is able to examine vast numbers of possible solutions from various perspectives with speed and accuracy. The task of supply chain management is a very complex task. The task can be simplified by applying Geographic Information Systems, which automatically reduce the complexity by bringing out subtle geographic patterns and relationships that can form the basis of good decisions. Systems like ArcLogistics Route can take pain out of applications like Vehicle Tracking and Dispatch, Route Analysis, Warehouse Operations, Facilities and Depot Management, Routing and Scheduling. GISs endeavor to unleash the inherent potential of the geography in most data sets we deal with today [5].

GIS analysis is more than the use of mapping software or the ability to plot points on a map. It is the ability to draw relationships spatially and to identify value in each relationship. An example would be the ability to follow product through its assembly process by locating key component supplier locations and routes from the supplier to manufacturing plant, and then from the manufacturing plant to distributor and then to the customer.

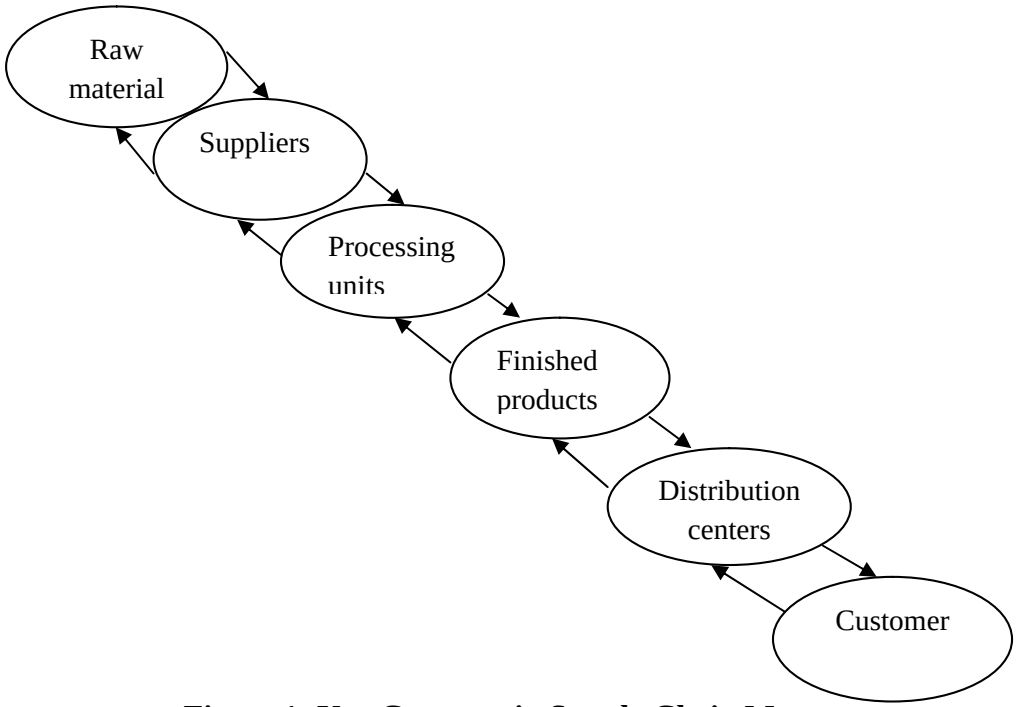

Figure 1: Key Concepts in Supply Chain Management

3. INTEGRATING GIS IN WEB SERVICES

The main focus has been on the ease of use and support for open standards in order to enable anyone to quickly share their geospatial information in an interoperable way. With the recent research on adopting web services for various GIS application, the issue of sharing spatial data has taken a new dimension. With web services, it becomes possible for applications to acquire and integrate spatial data from heterogeneous sources in real time over the web. OGC web services provide a vendor-neutral interoperable framework for web-based discovery, access, integration, analysis and visualization of multiple online geospatial data sources. Web Feature Service (WFS) and Web map Service (WMS) are the two important web service standards proposed by OGC and have been adopted in this project.

Web Feature Service (WFS): It is one of the GIS web service interoperable specifications defined by OGC (OGC, 2002). It is the most powerful data service of OGC Web Services. WFS allows a client to retrieve geospatial data from multiple geospatial data servers. It also supports INSERT, UPDATE, DELETE, QUERY and DISCOVERY operations on geographic features using HTTP as the distributed computing platform. WFS define three main operations: GetCapabilities operation describes capabilities of the web feature service using XML (it indicates which feature types it can service and what operations are supported on each feature type); DescribeFeatureType operation describes the structure of any feature type it can serve; GetFeature operation services a request to retrieve feature instances. In addition, the client should be able to specify which feature properties to fetch and should be able to constrain the query spatially and non-spatially.

Web Map Service (WMS): It is capable of creating and displaying maps that come simultaneously from multiple sources, in standard image formats such as Scalable Vector Graphics (SVG), Portable Network Graphics (PNG), Graphics Interchange Format (GIF) or Joint Photographic Expert Group (JPEG) (OGC, 2004). It provides three operations: GetCapabilities allows a client to instruct a server to provide its mapping content and processing capabilities and return service-level metadata; GetMap enables a client to instruct multiple servers to independently craft "map layers" that have identical spatial reference system, size, scale, and pixel geometry (the client can then display these overlays in a specified order and transparency such that the information from several sources is rendered for immediate human understanding and use); GetFeatureInfo enables a user to click on a pixel to inquire about the schema and metadata values of the feature(s) represented there.

4. OBJECTIVE OF THE PRESENT WORK AND STUDY AREA

The present work is carried out to facilitate effective supply chain management for PARAG co-operative dairy limited. It focuses on a very important GIS application i.e. enterprise management and planning. It shows how GIS can be used as a decision support for supply chain management. GIS can be used as a very effective tool for the applications that involve location and routing related problems. Because of this feature GIS is very efficient and effective in dealing with the logistics. The present work is done to develop a GIS based supply chain management system. The enterprise for which the work is carried out is PARAG co-operative dairy limited. Badaun district of western UP region is taken as the study area. There are three types of units in PARAG dairy. The Samities are opened at village level, in these Samities the

milk is collected from the villagers. Then this milk is sent to the processing plants. The pasteurization of milk is done here. After the pasteurization the milk is sent to the manufacturing units where this milk is converted in to packaged milk and milk products. The supply chain exists between Samities, processing plants and manufacturing units. The main problems that arise here are the on time supply, following the shortest route, tracking the good and deciding how to expand the business.

5. SYSTEM ARCHITECTURE

5.1 Methodology

The present work is done to develop a GIS based supply chain management system. The enterprise for which the work is carried out is PARAG co-operative dairy limited. Badaun district of western UP region is taken as the study area. ArcGIS 9.3 has been used for creating various thematic maps including road network map and the map showing different Samities and the processing plants. The system will answer two types of queries. One is the network related queries and the other is the location related queries. The system can be used as an information system and also as a decision support system for the decision makers. Figure 2 Shows the overall methodology adopted for creating the system architecture for the GIS based DSS for supply chain management.

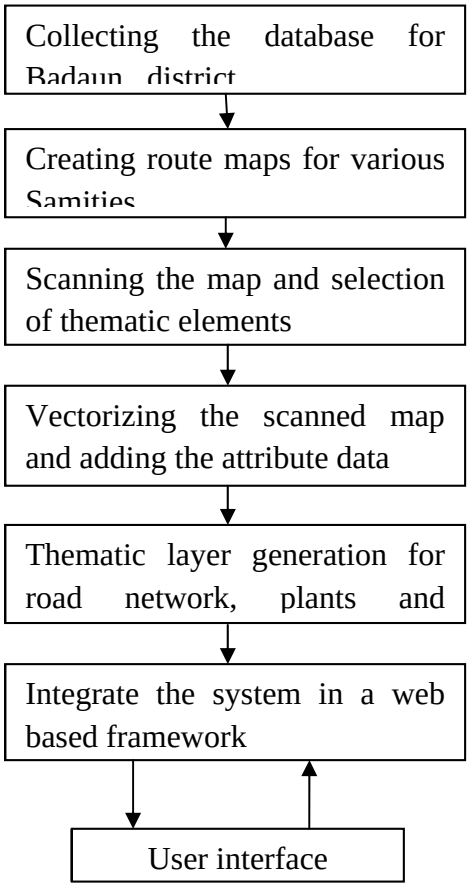

Figure 2: Methodology Adopted

5.2 Implemented Web GIS Architecture

Development of the Web and expansion of the Internet provide two key capabilities that can greatly help geoscientists. First, the Web allows visual interaction with data. By setting up a Web Server, clients can produce maps. Since the maps and charts are published on the Internet, other clients can view these updates, helping to speed up the evaluation process. Second, because of the near ubiquitous nature of the Internet, the geospatial data can be widely accessible. Clients can work on it from almost any location. Both of these features altars the way geoscientists do their work in the very near future. The combination of easy access to data and visual presentation of it addresses some of the primary difficulties in performing geosciences evaluations. For the creation of integrated geospatial database, the present work uses ArcGIS software. Geoserver and Apache Tomcat have been integrated for imparting the geospatial web capabilities with respect to Web Map Services (WMS), Web Feature Services (WFS) and Web Coverage Services (WCS). Geospatial web capabilities indicate to a web based GIS which can be modelled using the client-server architecture. In the present Web GIS architecture, a thin client model is used, where most of the processing work is done on demand in the server and the client does not perform any task other than to display the data on screen. MySQL is used for storing of security aspects and non-spatial data for decision making. PHP: Hypertext Preprocessor language has been used for dynamic server side scripting in the framework. PostgreSQL and PostGIS are the Geospatial databases where the shape files are stored. Figure 3 Shows the Web GIS Architecture used.

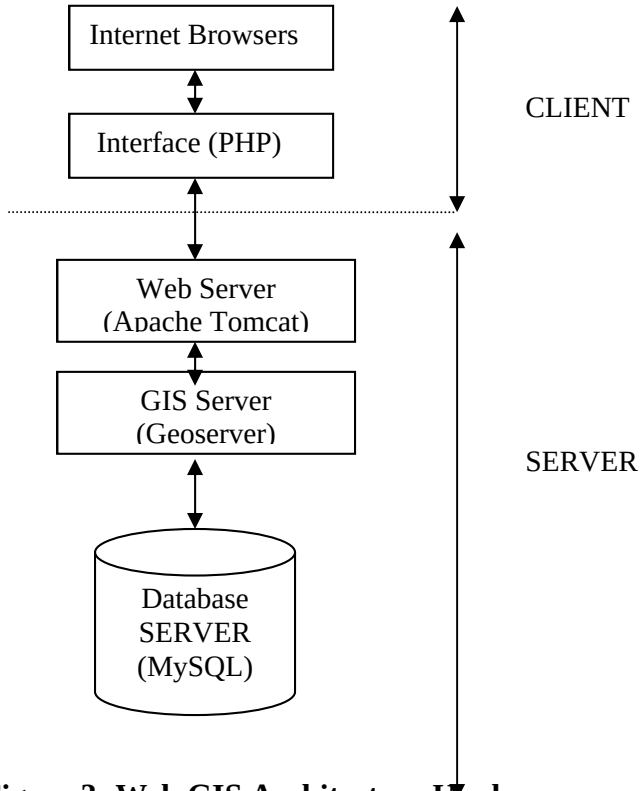

Figure 3: Web GIS Architecture Used

For development of Web GIS Architecture, the main focus has been on the use of a practical approach to explore and extend the concept of Supply chain Management in context with GIS. The framework should provide an effective and efficient means of sharing geospatial data and non-spatial data on the web using GIS in a secure way.

6. OVERALL DESIGN: SYSTEM DEVELOPED

For the development of the overall system the incremental development strategy used that allows the problem of constructing the architecture to be tackled in smaller, more manageable portions of increasing complexity. The incremental approach can be likened to 'building blocks'; incrementing each time a new component is added or integrated, based on an overall design solution. When all of the components are in place, the solution is complete. In addition, it is expected that each module would reveal unique features related to the requirements of the underlying infrastructure and enable exploration of the interfaces between the distributed Web GIS components.

The developed prototype distributed WebGIS model has been associated with two types of users, *i.e.*, administrative user and general user. The administrative user will have the authority to view, delete and find existing users which are associated with this system. The general user has the variety of option like login, logout, register, and get-information, maximize map, minimize map, get feature, get-coordinate, upload files and download files. The design phase involves the creation of road network database, Plants and Samities in the study area. Spatial data have been created in the form of shape files. These shape files are used for retrieval, maintenance and deployment on the web.

The complete framework consists of five modules, *i.e.* module I for registration; module II for Roads Network; module III for Plants; module IV for the Samities and Module V for the Services. Module I describes the detailed process to register the user for authentication. After registration process, user can use the Web GIS with full phase operation. Module II gives detailed viewing of Road Network and related data files. Module III gives detailed viewing of various factors associated with Plants and related data files. Module IV gives detailed viewing of various factors associated with Samities and related data files The Module V provides the online services i.e., the queries made by user to find shortest path, alternate route,distance between different units and travel time between different units. Integrating all the modules gives the overall system developed. Figure 4, 5, 6 and 7 shows the illustrations for the GIS based DSS for Supply Chain Management.

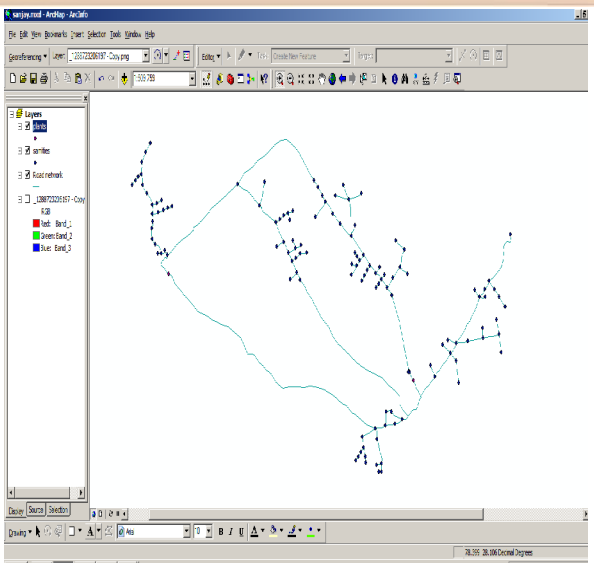

Figure 4: ArcGIS Map Window

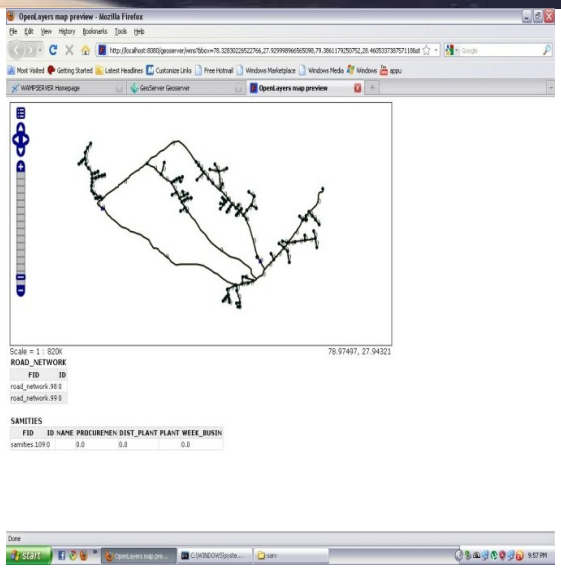

Figure 5: Geoserver Map Window

Figure 6: Geoserver Map Window (Showing all samities)

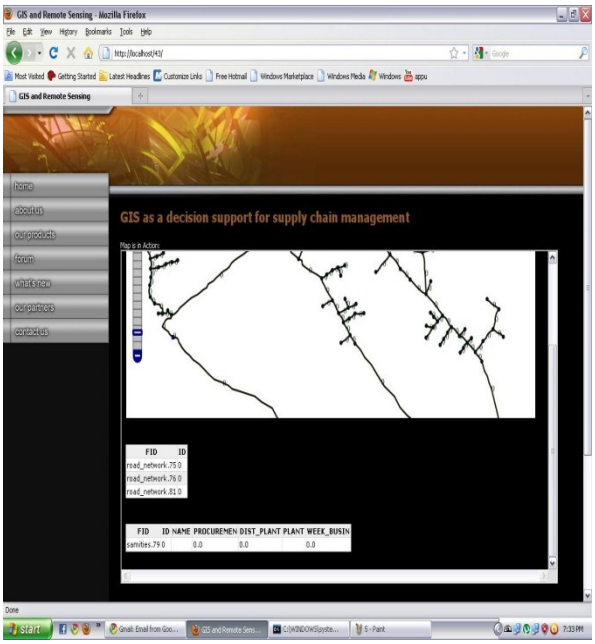

Figure 7: Map Window (Exporing the complete map)

7. CONCLUSION AND FUTURE WORK:-

In this paper we presented the architecture and design of a supply chain management system that we have to be fully developed. The system will serve various purposes of the supply chain managers. The system can be used as a decision support for the supply chain management. It will answer to many queries of the user. In future the study area can be increased and a supply chain management system for a larger area can be developed. The area can be extended to the whole state of uttar Pradesh. An analysis can be performed to find the impact of this organization on rural development and to propose how this organization can be more effective in rural development.

REFERENCES

1. ESRI, 1995. Understanding GIS: The ARC/INFO Method, Geoinformation International, UK, pp.1-2.
2. OGC, 2002. Web Feature Service Implementation Specification, version 1.0.0, OGC document 02-058 [http://www.opengeospatial.org/ specs/? page=specs.
3. OGC, 2004. Web Map Service, Ver. 1.3. OGC document 04-024 [http://www.opengeospatial.org/specs/?page=specs]
4. ISPRS, 2006. Web GIS : Technology and its applications
5. Sindh Univ. Res. Jour. (Sci. Ser.) Vol. 42 (1) 23-30 (2010), DEVELOPING COMPONENTS OF WEB GIS FOR SHORTEST PATH ANALYSIS “FIND SHORTEST ROUTE”
6. Routing Analysis in Supply Chain Management (SCM) – A Manager’s Perspective :Dr. vinod, Dr. s. subhas
7. National Workshop on Corporate GIS, 1999-GIS in logistics and vehicle routing applications : shubhbrata marmar

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